# The Production Problem

**By GROUP CAPTAIN H. R. FOOTTIT**

> "Here is the area of deep concern — the Soviets are presently beating us at our own game — production."
> —*General Thomas D. White, Deputy Chief of Staff, U.S. Air Force.*

THE HOUSE thundered its approval. Amid the tumult Winston Churchill stepped down from the speaker's stand. There was no doubt about it, his visit to Canada, on this cold wintry day in December, 1941, and his speech to the Canadian House of Commons, were an unqualified success. All Canada cheered his fighting words. For he had made it clear that World War II was in the "build-up" stage, and the Allied nations must look to their arms and prepare for the big battles yet to come. "How long this period will last!" he had said, "depends upon the vehemence of the effort put into production in all our war industries and shipyards."

Churchill had come to Canada in the midst of his clandestine "Arcadia" conference with Roosevelt. With the Japanese attack on Pearl Harbor only three weeks past, the great English speaking nations were now united in war against a common foe. And war meant arms. And arms meant production. Consequently Churchill and Roosevelt had spent many hours in the White House leafing over production plans. The pre-Pearl Harbor estimates, compiled by Beaverbrook from the U.K. and Harriman from the U.S., had called for the production of 28,000 operational aircraft in 1942. But the Arcadia conference upped these calculations. Jubilantly Churchill cabled home. The goal was now 45,000 operational airplanes in 1942, and 100,000 in 1943.

**Numbers Racket:** In 1942, as today, these figures approached the astronomical. The President was accused of going in for the "numbers racket." Even the great production boiler house of the U.S. couldn't cope with such colossal numbers, or even come close to them. Still, they were real and necessary targets. And if we were faced with another global war today, we would be faced with similar stupendous production goals. Yet what have we done, in the 15 years since Churchill stood before the Canadian House of Commons, to simplify aircraft so that they can be readily produced?

The bare fact is that we of the Western World have spent billions for aerodynamics and have an empty pocket book for production. We are sadly out of balance. And since we lack a fundamental foundation for easier production, we are hooked on the horns of a dilemma. Dean P. Stowell, Assistant to the President of Canadair Limited, summed up the situation to the Society of Automotive Engineers during an aircraft production conference, "The individual contractor is faced with a paradoxical situation that says on one hand 'do something new and bold and different (in production tooling) in order to gain the potential advantage available' and says on the other hand, 'use caution; historical data does not disclose any successful operation that varies to any considerable extent from custom.' "

The products of this customary approach, that Dean Stowell talks about, date back at least to 1921, 35 years ago, when Imperial Oil brought two metal aircraft to Edmonton for northern operations. These were five-place, German Junkers machines. Each was powered by a single 175 hp. engine. With a big radiator mounted at the nose of the fuselage, the cowlings and structure from there back were corrugated aluminum alloy sheet. The Junkers was a cantilever monoplane, and the same type of corrugated metal skin ran chordwise over each wing. In a little over a year, both of Imperial Oil's metal Junkers were either wrecked or out of commission. But if we could bring back and strip down these old timers today, we would find the aluminum skin, metal fittings, rivets, and similar parts that are still used on our most modern transports. How far, then, have we progressed in producability in 35 years?

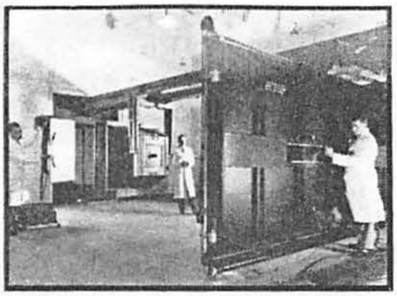
| ORDER | TYPE OF PRODUCTION PROCEDURE |
|---|---|
| 1 | Unique Product |
| 2 | Old Style Mass Production |
| 3 | New Style Mass Production |
| 4 | Process Production |

**FIGURE 1**
**Production Categories**

**Technique & Designs** To probe this production problem we can consider it in two sections, (a) production techniques, and (b) production design. In actual operations, of course, these are often interlocking parts of the same puzzle. Still, it simplifies the sequence if we can consider them separately.

From the hand-made, 1921 Junkers, to the tooled-up 1957 Canadair CL-28, the RCAF's maritime patrol version of the Bristol Britannia transport, there is obviously a vast difference in production techniques. Yet there is no doubt in my mind that there is still room for improvement. When we look at the production methods of the automotive and refrigerator industries, for example, we may feel that they have reached the zenith. Yet the industrial consultant, Peter F. Drucker, says in his book, *The Practice of Management*, "So universal is mass production today that it might be assumed that we know all about it . . . This is far from true. After 40 years we are only now beginning to understand what we should be doing."

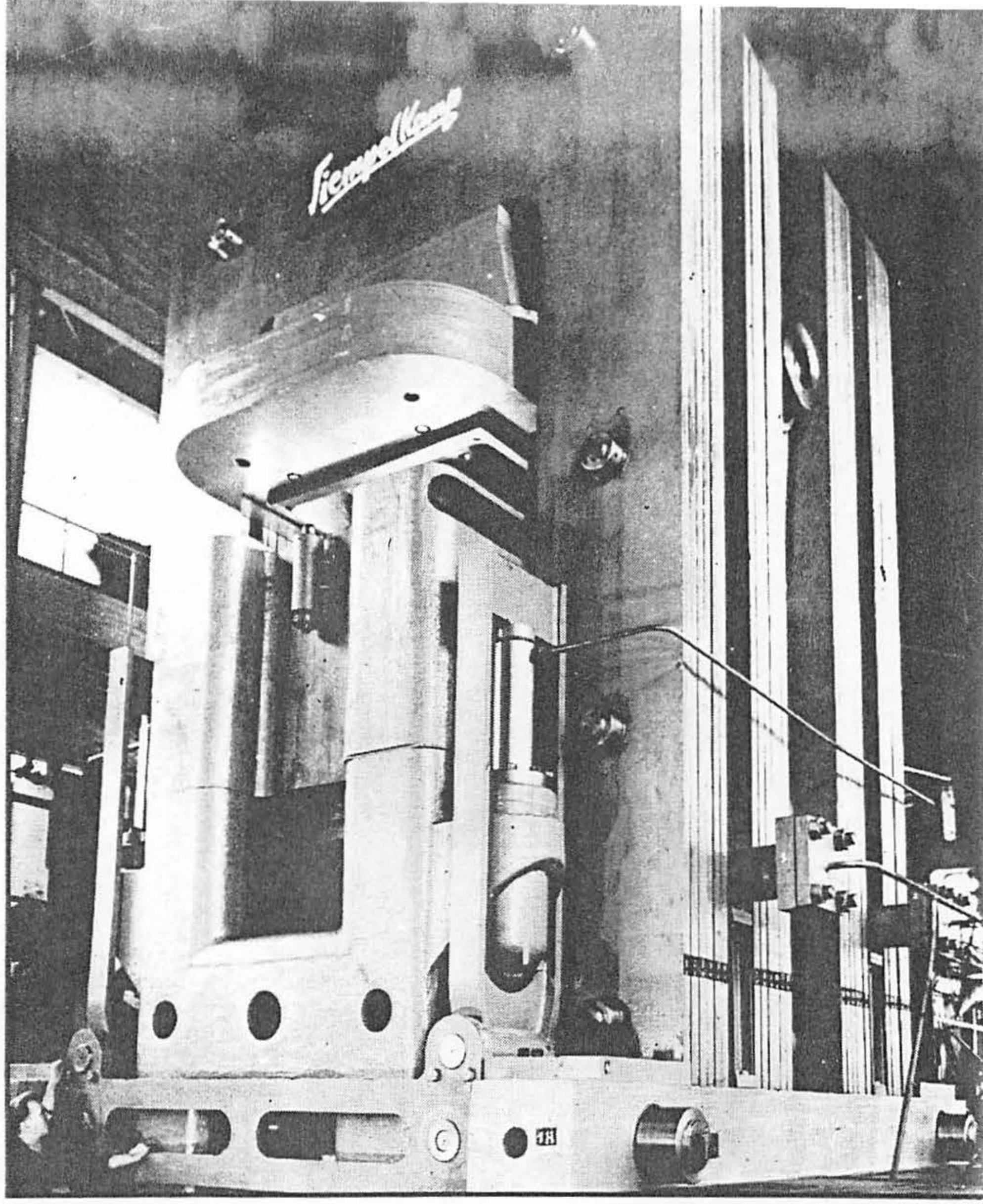
If the dawn of enlightment is just beginning to glow over the horizon for the real mass production industries, how far behind, then, is this dawn for the aircraft industries? Admittedly



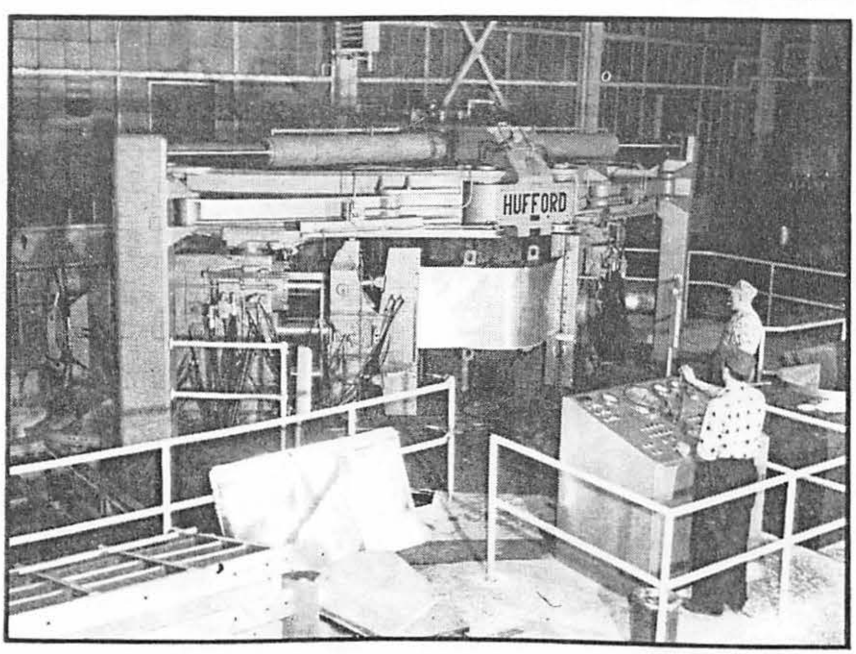
there are certain complexities to aircraft construction and procurement to plague the companies and force a compromise. As T. V. Chandler, Director of Administration, Manufacturing, for Canadair told the Canadian Aeronautical Institute in Winnipeg this year, "An aircraft project is doomed to failure by strictly following mass production procedures and techniques. It is therefore necessary that we, in aircraft manufacturing, pick and choose from both mass production and experimental production techniques, selecting methods and procedures which can be developed to meet our own particular problem."

**Elementary to Ultimate:** To appreciate the production problem it is necessary to categorize the various procedures that have stabilized since that day in 1893 when Henry Ford awed the residents of Detroit with his handmade "gas buggy". The four basic production systems are shown in Figure 1. They are also listed in order of merit. In other words, the Unique Product procedure is the most elementary, and Process Production the most refined. In general, all products tend to start in the Unique Product category and progress up to the ultimate, the Process Production scheme.

In brief, the *Unique Product* system is, as the name implies, a limited production procedure where every item is more or less different to the others on the line. Houses, battleships, wartime Liberty ships, and other such products fall into this class. The *Old Style Mass Production* system is the manufacture of uniform products in large quantities. This is the system that the automotive manufacturers pioneered. It was through this system that Ford could set his sights on 1,000 Model T cars a day in 1910, and shock into incoherence his business associates. It was refinements in this system that occupied Ford and his Model T production men for two decades and popularized such



**Though basically many of the structural components used in modern aircraft have little changed in the last 25 years, the tools used to make these parts have become bigger and more complex. Top L, Canadair's template camera, largest in use in Canada; above, Avro Aircraft's giant new rubber pad forming press, said to be biggest of its kind in the world; below, Canadair's stretch press.**



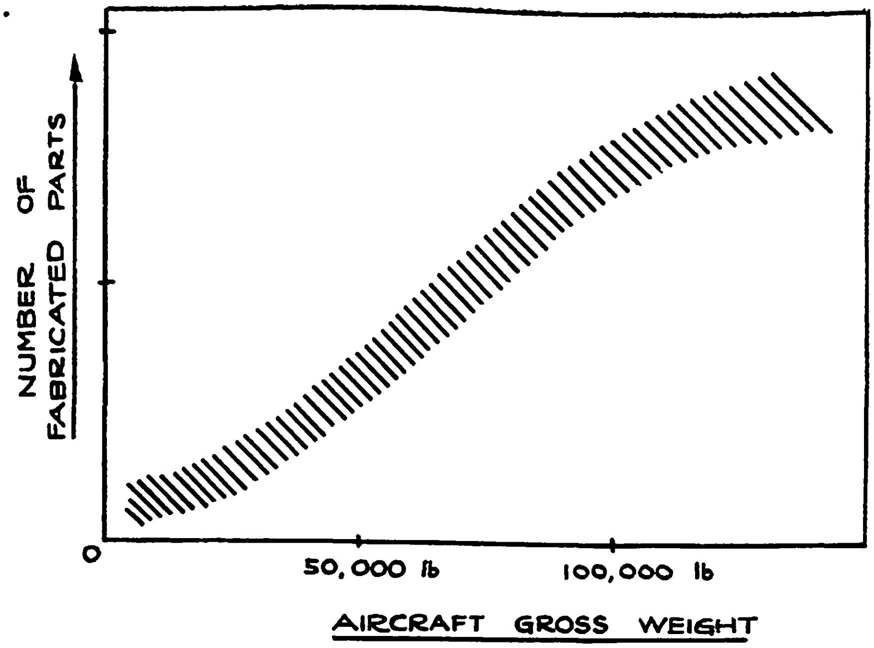



FIGURE 2
AIRFRAME PARTS

phrases as "You can have any color you want, as long as it's black."

The *New Style Mass Production* process is relatively recent. It probably will, in due course, supersede the Old Style scheme in many industries. In this case, the emphasis is on the mass production of uniform parts, which can be mass assembled, by selection, into a large variety of different products. This is the most powerful production concept in the manufacturing world today. But it is not easy to work out. It took one electrical manufacturer over three years to devise the basic part standardization that would permit the selective assembly of his 2,200 different products.

**Product & Process:** The most advanced system of the four, is *Process Production*. In this case, the product and the process are welded into one. This is the scheme that is used in the chemical and oil refinery business. Its basic theme is continuous flow and automatic regulation. In one huge petroleum product plant, for example, three men at a control panel monitor the production of a vast plant covering acres of ground.

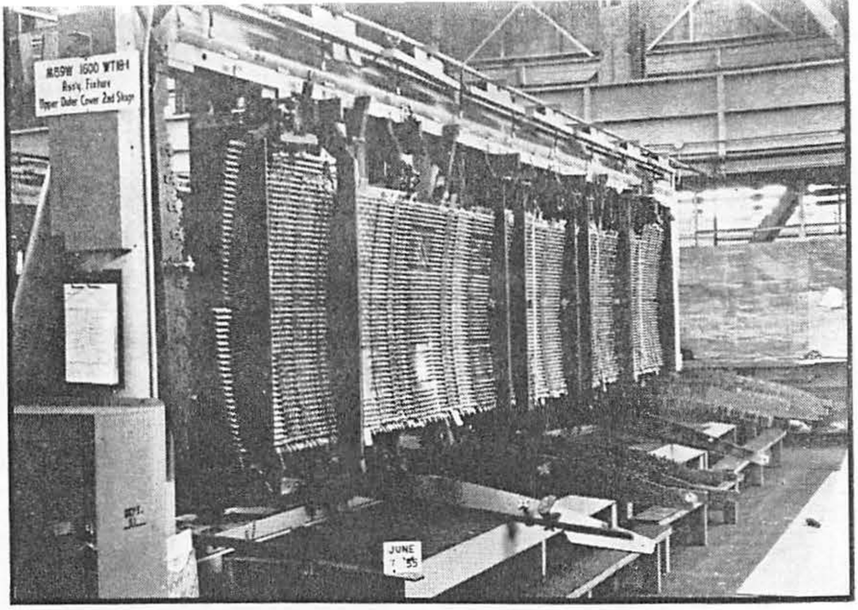
From a review of these basic production procedures it is apparent that some aircraft may touch on the Old Style Mass Production techniques, while most rest heavily on the lowest rung of the ladder, the Unique Product scheme. No matter what we do, we never seem to get it out of this category. There are too many stumbling blocks in peacetime that tend to make every airplane an individual item produced from minimum tooling. For example, money is tight and there is limited demand for the final product. If a civilian manufacturer can sell 300 of any airliner he cares to produce, this is front page news; or if he can churn out 1,000 of one type of fighter he has saturated his military market. On top of this, advances in technology, or correcting of design deficiencies, keep a never ending flow of modifications going. And operational requirements, both civil and military, demand peak efficiency, which in turn demands continual change. Thus, day after day, cost, change, and limited numbers keep us tied to the most rudimentary production process.

If we think and operate this way in peacetime, is it any wonder we can't shake off these shackles when war arrives? On that day we will need airplanes by the thousands. With present techniques our industry will be taxed to the extreme turning out fighters, patrol aircraft, helicopters, and other military vehicles for the RCAF, and equally important, cargo transports and airliners for the supporting services of Trans-Canada, Canadian Pacific and the other Canadian air carriers. In 1940 Winston Churchill wrote to President Roosevelt: "It takes between three and four years to convert the industries of a modern state to war purposes." In this age of the atom, who can say whether we will have such time to prepare our arms.

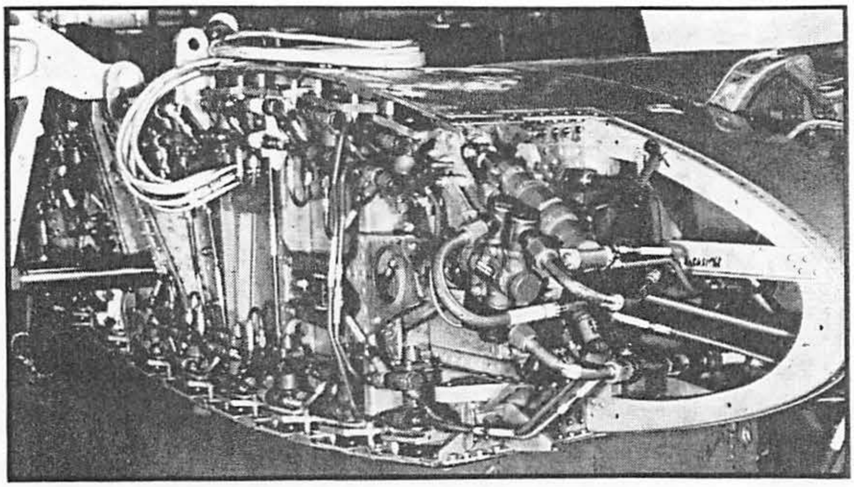
**Production Design:** Leaving the production technique side, let's have a look in the production design department. Undoubtedly in the 35 years since the day of the Junkers, we have made some progress. We have refined our engineering data so metal aircraft structures can be designed and stressed for higher loads, with more efficiency, than ever before. The net result is a saving in weight. But when we sift the details, a lot of this weight saving in metal monocoques can be credited to the metallurgist. Hunched over his test tubes and spectroscope, he is the one that has really led the way with high strength structural materials. The aeronautical engineer has plodded in his path, designing the shape of these new metals exactly as he did those of the past. In other words, the aeronautical engineer has been of little help to the production man.

Take for example, the number of parts that must be designed for the modern aircraft. In general, the more parts there are, the harder and costlier the aircraft is to produce; more bits and pieces must be processed and put together. Thus the manufacturing time and the assembly time are both stretched out. There has been some tendency to reduce the number of parts in modern airplane structures. But on the whole there hasn't been great changes and the number of parts still tends to increase with the size of the aircraft as shown in Figure 2. So we can ask ourselves, "What have we done through the years to really design airplanes to reduce the number of parts, simplify manufacture, reduce assembly time, and cut costs?"

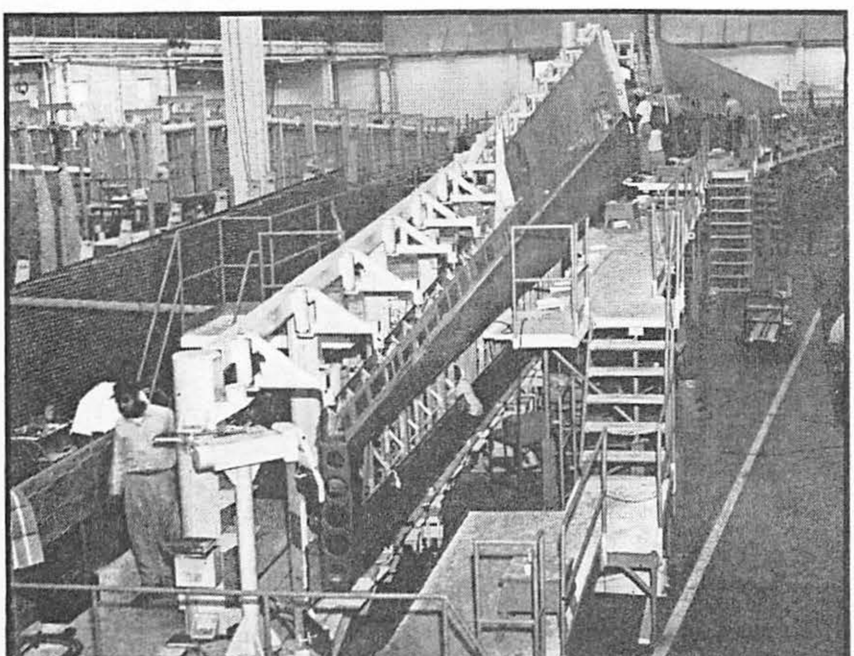
Very little, I think. In fact on both the design side and the technique side, we have been woefully wanton. But what can we do about it? In the first place, here in Canada, we need some stability in the government agencies, both service and civilian, that are charged with setting the policy and pace for our production industries. With this stability will come staffs that know production and its problems—not sup-



**Photos show complicated structure of CS2F components under construction at CanCar's Ft. William plant. Above, drilling and rivetting corrugations to outer skin of wing panel; below, wing-root end of centre section, showing the maze of electrical cables, hydraulic lines, and wing-fold joint fittings.**



**Use of machined integral stiffening whereby airframe structural parts are machined from solid stock is spreading rapidly. Below, new Lockheed 1649A wing, near completion. Integral stiffening is evident on lower panel in left background.**



erficially, but from real, honest working knowledge. And once this occurs, new plans and programs will be planted. Encouragement and enthusiasm for better production design and better production techniques will blossom forth. We should be able to steer a course straight to the heart of this production problem.

**Ups & Downs:** The RCAF and the RCN, the big operators of Canadian aircraft, have an indirect interest in this production problem and its industrial base. So do other government departments. But the agency that has the direct interest is the Department of Defence Production. For 17 years now, this important department, and its predecessors, has had a hectic career—the very opposite of stability.

In July, 1939, the Defence Purchasing Board was set up to carry out all defence procurement. In a matter of months it was superseded by the War Supply Board, and in early 1940 by the Department of Munitions and Supply. This latter agency carried the heavy load of wartime procurement until it too, came to an end after the war and the Canadian Commercial Corporation took over the job. On April 1, 1951, with the bullets flying in the Korean conflict and defence purchasing weighing heavily on the budget, the Department of Defence Production was born. It was initially given a lifetime of 5 years. A heavy barrage was aimed at its terms of reference during last year's parliamentary session. But it managed to struggle through to get its life extended indefinitely.

Since a true understanding of production takes years to master, it is not surprising, with such ups and downs, that we in Canada have never really probed the production problem. Since 1951 we have spent almost $2 billion on aircraft programs and over $175 million in capital assistance—to set up the airframe, engine, and accessory manufacturers with the tools and facilities—yet we haven't spent a penny on trying to improve aircraft production design and techniques. For instance, have we ever asked our National Research Council or our National Aeronautical Establishment to dig into design parameters for producability? And if we did, would they be staffed and set up to tackle such a chore?

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The guesstimate of 15,000 lb. thrust per engine is derived from the duct size and the consumption of 5,100 Imp. gallons during the 3½-hour 1,500-mile flight from Moscow to London. It could be the 18,000 lb. thrust credited to the Badger—the intakes are large enough—depending upon engine efficiency. There is no question of the engines being "crude" or "rough"; the fuel used indicates contemporary consumption. As far as performance goes, the Caravelle is flying well on two 10,500 lb. engines.

The engines are mounted behind the wing spar and the nacelle line lies mainly below the wing. This gives a clear air duct run under the torsion box, with low structure weight and low duct losses.

The jet pipes are slightly splayed out and there are large fillets to take the initial jet buffeting, but even so they are very close to the pressure skin for such high powers.

Fuel seems to be carried in the torsion box from tip to tip—through the fuselage. Total is 8,000 Imp. gal. Fuel is also carried in the tail fuselage as ballast. This means a long fuel line through the pressure volume. (This is done for a short distance in the Caravelle, using a steel duct vented to the atmosphere.)

The Russian's claim of 500 mph plus cruising speed seems perfectly reasonable, as is that for a maximum range (presumably stage length) of 2,000 statute miles. The cabin differential is low, giving a cabin altitude of 10,000 ft. at 33,000 ft.—or 6.25 lb./sq. in. Individual oxygen is provided at each seat. The airplane flew the fifteen hundred miles from Moscow to London at a block speed of 447 mph, which appears to confirm the speed claim, since the let-down was in bad weather. The return trip was made at 484 mph.

**Electronic Aids:** The Russian's claim that it has more radio and radar aids than any other transport—this is surely true of the visitor. Although it still has the characteristic Soviet "washing line" MF aerial from cockpit to fin, it has VHF, UHF external and suppressed aerials, some most unusual ones along the cabin roof, radio altimeter and H2S—it has no visible homer however.

Summing up, the writer would say that external evidence shows the Tu-104 to be in line with current thinking and practice; neither a copy, nor yet strikingly original. It is well built and should have a contemporary performance. Personally, I would call it a troop transport first and an airliner second. The use of Badger components will make it easy to produce rapidly in quantity and, even if it lacks certain Western standards in pressurization and economy, it may well be offered in the World markets at a cut price.

## PRODUCTION PROBLEM

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**Plans & Policies:** There are other plans and policies that might accrue from stabilized and understanding agencies in Ottawa. The services, for example, might take another look at their continual change and modification programs. The financial experts might invest in more peacetime tooling, to foster the techniques and decrease the production risks if war were to start tomorrow. The aircraft companies, too, might feel free to come forward with advanced thoughts on production processes, or even propose experimental programs aimed at simplifying the design and tooling problems.

There are obviously many such facets to this production problem. But one thing is certain, we are sadly out of balance between our ideas and expenditures on pure technical aspects, and those on producability. Too long have we hewed to the straight technical line. It is no wonder, then, as General White of the U.S. Air Force has warned, that the Soviets are beating us at our own production game. Lord Trenchard, "father" of the Royal Air Force, wrote a letter to the London Times, which, I think, sums up the situation very adequately. "It has taken too long from the time the machine is on the drawing board, to the time it is in the front line. For many years now there has been no improvement in the delay in production except that 'super' has been added to the word 'priority', which has had no effect, of course, on production."

It's high time we stopped bandying words on this production problem, as Lord Trenchard said and start doing something concrete about a solution.